APPLICATION FOR UNITED STATES PATENT

FOR

LUMINESCENT AND ILLUMINATION SIGNALING DISPLAYS UTILIZING A MOBILE COMMUNICATION DEVICE WITH LASER

Inventors
Daniel Shapiro
G. Eric Engstrom
Peter Zatloukal

Prepared by: Schwabe, Williamson & Wyatt, PC
Suites 1600-1900
1211 SW Fifth Ave.
Portland, OR 97204

Attorney Docket No.: 109909-133501
IPG No: P065X

Express Mail Label No. EV069127641US
Date of Deposit: July 28, 2003

LUMINESCENT AND ILLUMINATION SIGNALING DISPLAYS UTILIZING A MOBILE COMMUNICATION DEVICE WITH LASER

Related Application

This application is a continuation-in-part application of application number 10/334,736, filed on Dec 31, 2002, entitled "Luminescent Signaling Displays Utilizing A Wireless Mobile Communication Device", which itself is a continuation-in-part application of application number 09/908,118, filed July 17, 2001, having the same title.

FIELD OF PRESENT INVENTION

The present invention relates to the field of wireless mobile communication device. More specifically, the present invention relates to facilitating luminescent and illumination signaling displays utilizing a wireless mobile communication device.

BACKGROUND OF THE PRESENT INVENTION

Advances in integrated circuit and telecommunication technology have led to wide spread adoption of wireless mobile client devices, in particular, wireless mobile communication devices. Wireless mobile communication devices, such as wireless mobile phones, offer the advantage of enabling their users to be communicatively reachable by their business associates, friends and family members, wherever the users may be, as long as they are within the reach of the service networks. Because the wireless mobile phone is prevalent, often times, users consider wireless mobile phones as their first medium of communication, even if a traditional wired line telephone is available, such as, in a users home. It is often the case, where a user will pick up

their wireless mobile phone before they pick up their traditional wired line telephone. Thus, even non-professionals are increasingly dependent on their wireless mobile phones to meet their communication needs. However, there may be situations where traditional functions of a wireless mobile phone may be inadequate for a user's communication needs.

For example, if a user is within visual range of another person, with whom the user wishes to communicate, the user may talk very loudly. Talking very loudly may be ineffective if the area is noisy. Another method may be to use hand signals, which may be ineffective to convey a message due to the cryptic nature of hand signals. Making a large physical sign for display may be another method, but again, this method may be ineffective if the area is relatively dark.

The user may use a wireless mobile phone to call the other person; however, calling the other person will require the other person to have his/her own wireless mobile phone. It also requires knowledge of the other person's phone number. Additionally, the difficulties of communicating in less than ideal conditions, such as noisy conditions, will not be resolved by calling the other person using the wireless mobile phone.

The afore described difficulties with using wireless mobile phones apply equally to other wireless mobile communication devices, such as, wireless mobile pagers, instant messengers, and so forth.

Note: The term "wireless mobile phone" as used herein (in the specification and in the claims) refers to the class of telephone devices equipped to enable a user to make and receive calls wirelessly, notwithstanding the user's movement, as long as the

user is within the communication reach of a "service station" of a wireless telephony service provider. Unless specifically excluded, the term "wireless mobile phone" is to include the analog subclass as well as the digital subclass (of all signaling protocols). Further, wireless mobile communication devices will simply be referred to as wireless mobile devices or wireless communication devices. Unless the specific context requires otherwise, in the general context of this application, the two terms are used interchangeably.

BRIEF DESCRIPTION OF DRAWINGS

The present invention is illustrated by way of example and not by way of limitation in the figures of the accompanying drawings, in which like references indicate similar elements and in which:

FIGURES 1A – 1C illustrate one embodiment of a wireless mobile device, specifically, a wireless mobile phone, incorporated with the teachings of the present invention;

FIGURES 2a-2b illustrate exemplary luminescent images facilitated utilizing a wireless mobile phone, in accordance with one embodiment of the present invention;

FIGURE 3 illustrates effects of different types of motion on the spatial painting of luminescent images using LEDs of a wireless mobile phone, in accordance with one embodiment of the present invention;

FIGURES 4A & 4B illustrate an alternate embodiment of the present invention for spatially painting luminescent images facilitated by utilizing a wireless mobile phone;

FIGURES 5A & 5B illustrate spatial painting of luminescent images facilitated by utilizing a wireless mobile phone, in particular, utilizing a wireless mobile phone body casing have an increased number of LEDs in a matrix arrangement, in accordance with an alternate embodiment of the present invention;

FIGURE 6 illustrates facilitation of spatial painting of luminescent images utilizing a wireless mobile phone in an alternate configuration;

FIGURES 7A & 7B illustrate means for augmenting motion of a wireless mobile phone utilized to spatially paint a luminescent image, in accordance with one embodiment of the present invention;

FIGURES 8A-8C illustrate spatial painting of luminescent images utilizing a wireless mobile phone having a body casing comprising two portions, one of which is interchangeable, in accordance with the teachings of the present invention;

FIGURE 9 illustrates an internal component view of a wireless client device such as wireless mobile phone, in accordance with one embodiment of the present invention;

FIGURE 10 illustrates an internal component view of storage/microprocessor chip embedded in an interchangeable covering, such as the storage/microprocessor chip, in accordance with one embodiment of the present invention;

FIGURE 11 illustrates turning on and off LEDs to spatially paint a luminescent image in further details, in accordance with one embodiment of the present invention;

FIGURE 12 illustrates an operational flow of the complementary logic as it applies to the facilitation of spatially painting luminescent images utilizing a wireless mobile phone, in accordance with one embodiment of the present invention;

FIGURES 13a-13c illustrate spatial painting of illumination images utilizing a wireless mobile phone, in accordance with another family of embodiments of the present invention;

FIGURE 14 illustrates the light source arrangement of the wireless mobile phone of **Fig. 13a-13c** in further details, in accordance with one embodiment;

FIGURES 15a-15c illustrate the light source arrangement of the wireless mobile phone of **Fig. 13a-13c** in further details, in accordance with a number of other embodiments;

FIGURE 16 illustrates the light source arrangement of the wireless mobile phone of **Fig. 13a-13c** in further details, in accordance with another embodiment;

FIGURE 17 illustrates the light source arrangement of the wireless mobile phone of **Fig. 13a-13c** in further details, in accordance with yet another embodiment; and

FIGURE 18 illustrates a color light source arrangement of **Fig. 15a-15c** in further details, in accordance with one embodiment.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE PRESENT INVENTION

For ease of understanding, the present invention will be described in the context of wireless mobile phones. However, it is anticipated that the present invention may be practiced on all wireless mobile devices, i.e. phones, pagers, instant messengers and other devices of the like. Thus, the references to wireless mobile phones in the description are merely illustrative, and are not to be read as limitations on the claims.

In the following description, various embodiments of the present invention will be described. However, it will be apparent to those skilled in the art that the present invention may be practiced with only some or all aspects of the described embodiments. For purposes of explanation, specific numbers, materials and configurations are set forth in order to provide a thorough understanding of the present invention. However, it will also be apparent to one skilled in the art that the present invention may be practiced without these specific details. In other instances, well-known features are omitted or simplified in order not to obscure the present invention.

Parts of the description will be presented in terms of operations performed by a computer system, using terms such as data, flags, bits, values, characters, strings, numbers and the like, consistent with the manner commonly employed by those skilled in the art to convey the substance of their work to others skilled in the art. As well understood by those skilled in the art, these quantities take the form of electrical, magnetic, or optical signals capable of being stored, transferred, combined, and otherwise manipulated through mechanical electrical, and/or optical components of the computer system, and the term computer system includes general purpose as well as

special purpose data processing machines, systems, and the like, that are standalone, adjunct or embedded.

Various operations will be described as multiple discrete steps in turn, in a manner that is most helpful in understanding the present invention, however, the order of description should not be construed as to imply that these operations are necessarily order dependent. In particular, these operations need not be performed in the order of presentation.

In various embodiments of the present invention, generating and displaying luminescent images are facilitated utilizing a wireless mobile phone.

FIGURES 1A – 1C illustrate one embodiment of a wireless mobile device, specifically, wireless mobile phone, incorporated with the teachings of the present invention. As illustrated in a side view of a wireless mobile phone in **FIG. 1A**, wireless mobile phone **100** is provided with a number of light emitting diodes (LEDs) **110** disposed on side surface **105** of the body casing of the wireless mobile phone **100** in a substantially columnar manner, along an imaginary longitudinal axis **111** of the wireless mobile phone **100**. For the illustrated embodiment, eight (8) LEDs are provided and disposed in a substantially linear manner. In one embodiment, nine (9) LEDs are provided and disposed in a substantially linear manner. In alternate embodiments, more or less LEDs may be provided and/or arranged in other geometric configurations instead, as well as disposed in other or multiple exterior surfaces of the wireless mobile phone **100**, including the top or bottom surface, the front or back surface, and combinations thereof. Further, while the present invention is being described in terms of LEDs, the term as used in this application (including the claims) is to be broadly

construed to include all lighting sources of like kind. In other words, it is anticipated that the present invention may be practiced with other similar light sources beside LEDs.

Shown in **FIG. 1B**, a frontal view of the wireless mobile phone **100** includes display area **120**, a speaker area **121**, a microphone area **122**, various keys **123** having alphanumeric functions, and an optional antenna **124**. A user (not shown) may select or enter a desired image, such as, for example, the textual image "SEE YOU," by methods utilizing the various keys **123**. This image may be displayed on the display area **120** for the user, providing feedback to the user on the selected or entered image. However, by virtue of the typical relatively small dimension of display area **120**, this image on the display area **120** of wireless mobile phone **100** is too small to convey the image to other people visually, unless the other users have the wireless mobile phone **100** directly in front of them. In accordance with the present invention, the image may be conveyed to other people or users visually as a spatially painted luminescent image using LEDs **110** and complementary logic (e.g. block **907** of **Fig. 9**).

Each of the LEDs **110**, shown in **FIGS. 1A & 1B**, may represent various types of LEDs that alone or in combination with other LEDs form a single pixel of the spatially painted luminescent image. For example, each of the LEDs **110** may be one single-color LED, or one multi-color LED (i.e., a single LED that can light in different colors). In one embodiment, each pixel is formed using three single color LEDs. The three single colors are red **130**, green **131**, and blue **132** (shown in **FIG. 1C**).

In the embodiments shown, the LEDs **110** are employed to facilitate spatial painting of luminescent images utilizing the wireless mobile phone **100**. As will be described below, images may include visual images, such as, but not limited to

alphanumeric characters, words, phrases, shapes, and animated images, each in a single color or in a mixture of colors.

FIGURE 2a illustrates an exemplary luminescent image facilitated utilizing a wireless mobile phone, in accordance with one embodiment of the present invention. As shown in **FIG. 2**, the wireless mobile phone **100** having the LEDs **110** embedded in the body casing in the aforementioned manner is spatially moved horizontally in a side-to-side motion. More specifically, the spatial movement spans a plane substantially perpendicular to an intended recipient's line of vision. As the wireless mobile phone **100** is moved side-to-side in the described horizontal manner, the LEDs **110** are selectively activated, i.e., turned on and off, in various patterns in a manner timed to coordinate with the spatial movement to effectuate formation of a luminescent image **220**, visible to the recipient.

The side-to-side motion may be achieved by a number of alternate mechanisms. In one technique, the user holds the wireless mobile phone **100** in one hand, with the LEDs **110** directed towards the intended recipient of the luminescent image **220** and the longitudinal axis **111** of the wireless mobile phone **100** oriented approximately vertical, and moves the wireless mobile phone **100** side-to-side horizontally. The side-to-side motion includes moving the mobile phone **100** in a first direction **210** horizontally, then reversing the direction, and moving the mobile phone in an opposite direction **211**, also horizontally. The reversal of directions can be repeated a number of times. An image or a string of text may be repeatedly painted upon each movement in a single direction. Alternatively, the image or string of text may change upon reversal of directions, in order to spell out a longer string of text or a sequence of images. The luminescent image **220**

is perceptually sustained, as the wireless mobile phone **100** is moved in the side-to-side motion horizontally, and the LEDs are repeatedly activated/deactivated in a spatial movement dependent manner.

The luminescent image **220** (shown in **FIG. 2**) is painted utilizing the wireless mobile phone **100** by selectively activating LEDs **110** (turning on and off) at a rate appropriate for a phenomenon known as persistence of vision. Persistence of vision is a phenomenon that allows a human eye to see a trail of light when a person moves a light source around in the dark.

Thus, as the wireless mobile phone **100** is moved in the side-to-side motion at a faster rate, in most circumstances, the luminescent image **220** generally becomes clearer and sharper. However, if the wireless mobile phone **100**, having the LEDs **110**, is moved slower in the side-to-side motion horizontally, in most circumstances, the luminescent image **220** generally becomes less clear. The viewer, instead of seeing a steady image, may see a flickering or blurred luminescent image. The persistence of vision phenomenon is known, and accordingly, will not be discussed in further detail.

In one embodiment, an accelerometer (shown as ref. **950** in **FIG. 9**) may be utilized to determine the motion of the wireless mobile phone **100**. The accelerometer is employed to aid in coordinating the selective activation of LEDs **110**, to spatially paint a relatively clear luminescent image **220** at relatively slower side-to-side motions. The accelerometer measures the rate at which the speed of an object is changing, i.e., its acceleration, by measuring the forces exerted on its components, and these measurements are commonly transferred into electrical signals. The signals of the accelerometer can be used to determine when the wireless mobile phone reverses

directions. Additionally, the accelerometer may aid in indicating movements in different directions.

For example, referring to **FIG. 2a**, the accelerometer may aid in indicating changes in direction of motion between the first direction **210**, and the second direction **211** (i.e., left to right and right to left). Indicating changes in direction facilitates spatial painting of luminescent images corresponding to the direction of motion. For example, in **FIG. 2**, the luminescent image **220** may be spatially painted to be viewed in one direction, i.e., the LEDs are activated based on direction of motion to prevent differing images corresponding to the two directions **210** and **211**, one image in the first direction **210** and a reverse image in the second direction **211**. The image is painted in the first direction **210**, and then, painted in reverse in direction **211** presenting a backward image. These accelerometers are available in very small sizes, such as, but not limited to, a piezoelectric micro-miniature accelerometers, allowing it to be included in a variety of devices, such as, wireless mobile phone **100**.

FIGURE 2b illustrates an exemplary luminescent image facilitated utilizing a wireless mobile phone, in accordance with one embodiment of the present invention. As shown in **FIG. 2b**, the wireless mobile phone **100** having the LEDs **110** embedded in the body casing in the aforementioned manner is spatially moved in a top-to-bottom or bottom-to-top motion, vertically. More specifically, the spatial movement spans a plane substantially perpendicular to an intended recipient's line of vision. As the wireless mobile phone **100** is moved top-to-bottom or bottom-to-top in the described manner, the LEDs **110** are selectively activated, i.e., turned on and off, in various patterns in a

manner timed to coordinate with the spatial movement to effectuate formation of a luminescent image **240**, visible to the recipient.

The top-to-bottom or bottom-to-top motion may be achieved by a number of alternate mechanisms. In one technique, the user holds the wireless mobile phone **100** in one hand, with the LEDs **110** directed towards the intended recipient of the luminescent image **240** and the longitudinal axis **111** of the wireless mobile phone **100** oriented approximately horizontal, and moves the wireless mobile phone **100** top-to-bottom or bottom-to-top. The top-to-bottom or bottom-to-top motion includes moving the mobile phone **100** in a first direction **230**, then reversing the direction, and moving the mobile phone in an opposite direction **231**. The reversal of directions can be repeated a number of times. An image or a string of text may be repeatedly painted upon each movement in a single direction. Alternatively, the image or string of text may change upon reversal of directions, in order to paint a longer series of characters or a sequence of images. The luminescent image **240** is perceptually sustained, as the wireless mobile phone **100** is moved in the top-to-bottom and/or bottom-to-top motion, and the LEDs are repeatedly activated/deactivated in a spatial movement dependent manner.

The luminescent image **240** (shown in **FIG. 2b**) is painted utilizing the wireless mobile phone **100** by selectively activating LEDs **110** (turning on and off) at a rate appropriate for a phenomenon known as persistence of vision. Persistence of vision is a phenomenon that allows a human eye to see a trail of light when a person moves a light source around in the dark.

Thus, as the wireless mobile phone **100** is moved in the top-to-bottom or bottom-to-top motion at a faster rate, in most circumstances, the luminescent image **240** generally becomes clearer and sharper. However, if the wireless mobile phone **100**, having the LEDs **110**, is moved slower in the top-to-bottom or bottom-to-top motion, in most circumstances, the luminescent image **240** generally becomes less clear. The viewer, instead of seeing a steady image, may see a flickering or blurred luminescent image. The persistence of vision phenomenon is known, and accordingly, will not be discussed in further detail.

In one embodiment, as the earlier described embodiment, an accelerometer (shown as ref. **950** in **FIG. 9**) may also be utilized to determine the motion of the wireless mobile phone **100**. The accelerometer is employed to aid in coordinating the selective activation of LEDs **110**, to spatially paint a relatively clear luminescent image **240** at relatively slower top-to-bottom or bottom-to-top motions. The accelerometer measures the rate at which the speed of an object is changing, i.e., its acceleration, by measuring the forces exerted on its components, and these measurements are commonly transferred into electrical signals. The signals of the accelerometer can be used to determine when the wireless mobile phone reverses directions. Additionally, the accelerometer may aid in indicating movements in different directions.

For example, referring to **FIG. 2b**, the accelerometer may aid in indicating changes in direction of motion between the first direction **230**, and the second direction **231** (i.e., top-to-bottom and bottom-to-top). Indicating changes in direction facilitates spatial painting of luminescent images corresponding to the direction of motion. For example, in **FIG. 2b**, the luminescent image **240** may be spatially painted to be viewed

in one direction, i.e., the LEDs are activated based on direction of motion to prevent differing images corresponding to the two directions **230** and **231**, one image in the first direction **230** and a reverse image in the second direction **231**. The image is painted in the first direction **230**, and then, painted in reverse in direction **231** presenting a backward image. These accelerometers are available in very small sizes, such as, but not limited to, a piezoelectric micro-miniature accelerometers, allowing it to be included in a variety of devices, such as, wireless mobile phone **100**.

FIGURE 3 illustrates effects of different types of motion on the spatial painting of luminescent images using LEDs of a wireless mobile phone, in accordance with one embodiment of the present invention. As shown in **FIG. 3**, the wireless mobile phone **100**, having the LEDs **110** embedded in the body casing, is moved in an arcing motion **310**. The arcing motion of the wireless mobile phone **100** causes a "bent" luminescent image **320** to be spatially painted. The bent luminescent image **320** follows an arc path **330**, i.e., the path of the motion of the wireless mobile phone **100**. However, it should be appreciated that the luminescent images may be likewise spatially painted in shapes corresponding to various other paths of motion, beside the side-to-side, top-to-bottom/bottom-to-top, and arc motions described thus far. Moreover, the luminescent textual image may be painted in English or any one of a number of non-English language (such as Chinese), including languages with rendering orientations other than the left-to-right and top-to-bottom orientation of English.

In **FIGS. 1-3**, the body casing of the wireless mobile phone **100** has the LEDs **110** embedded in a substantially linear manner, along a longitudinal axis **111** of the wireless mobile phone **100**. As alluded to earlier, the body casing of the wireless mobile

phone **100** may have the LEDs **110** embedded in a variety of orientations with a preferred orientation having at least 8 LEDs arranged so that when the wireless mobile phone **100** is moved, the 8 LEDs form 8 parallel lines spread evenly apart. Alternatively, the wireless mobile phone **100** may have the LEDs **110** embedded in an orientation having at least 16 LEDs arranged to form 8 parallel lines (2 LEDs per line). Additionally, shown in **FIGS. 1-3**, the body casing of the wireless mobile phone **100** has eight LEDs **110**. Eight or nine LEDs is the preferred number, but the number of LEDs may be more or less than eight or nine. Additionally, as described above with respect to **FIG. 1**, the LEDs shown in **FIGS. 1-3** may be a variety of types of LEDs.

As a result, spatial painting of luminescent images may be effectuated utilizing a wireless mobile phone.

FIGURES 4A & 4B illustrate an alternate embodiment of the present invention for spatially painting luminescent images facilitated by utilizing a wireless mobile phone. **FIGS. 4A & 4B** show a wireless mobile phone having a body casing comprising two portions. One portion is an exposed wireless mobile phone **400** and the other portion is a covering **420**. One embodiment of the covering **420** is described below with respect to **FIG. 8B**. The exposed wireless mobile phone **400** and the covering **420** are oriented such that the left side of the exposed wireless mobile phone **400** (shown in **FIG. 4A**) corresponds to the right side of the covering **420** (shown in **FIG. 4B**), i.e., **FIG. 4B** is a view of the inside of the covering **420**.

Referring to **FIG. 4A**, the exposed wireless mobile phone **400** includes a speaker **410**, a microphone **411**, a display **412**, and a number of buttons **413**. In substantially the same locations as the buttons **413**, are a number of LEDs **415** in a matrix

arrangement (or multi-row, multi-column linear formations). The LEDs **415** are in the matrix arrangement to closely match the arrangement of the buttons **413** in order for the light of the LEDs to be visible through keys **425** (shown in **FIG. 4B**) which cover the buttons **413**. As previously described, the LEDs **415** (or other light sources) may be of single colors or multi-colors, of the same or different colors. The colors may include red **130**, green **131**, and blue **132** or other combinations (shown in **FIG. 1C**). The light sources may be arranged in any geometric configurations, and disposed on one or more exterior surfaces.

Referring now to **FIG. 4B**, the covering **420** includes a speaker area **421**, a display area **422**, a microphone area **423**, and a keypad **424** on which keys **425** are molded to facilitate the pressing of the buttons **413** on the exposed wireless mobile phone **400** (shown in **FIG. 4A**). The keypad **424**, in particular, the keys **425**, may be made of a translucent material to facilitate the viewing of the LEDs **415** disposed beneath, when the covering **420** is in place. In the illustrated embodiment of **FIGS. 4A & 4B**, a wireless mobile phone has a number of LEDs **415** in a matrix arrangement, placed close to the buttons **413**, underneath the keys **425** of the key pad **424**, allowing for an external appearance of a conventional wireless mobile phone. However, the LEDs may be arranged in a matrix arrangement on any of the exposed surfaces, such as, but not limited to, the back of a wireless mobile phone. In the illustrated embodiment, once the exposed wireless mobile phone **400** and the covering **420** are attached to each other, light emitted from the LEDs **415** are visible through the keys **425**. In a preferred arrangement, three LEDs are underneath each of the keys **425**, one red **130**, one green **131**, and one blue **132** (shown in **FIG. 1C**).

FIGURES 5A & 5B illustrate spatial painting of luminescent images by utilizing a wireless mobile phone such as the one described above in **FIGS. 4A & 4B**. Shown in **FIG. 5A**, wireless mobile phone **500** is moved in a side-to-side motion **510**, as previously described with respect to **FIG. 2**. In the one embodiment, the luminescent image painted is a shape, in particular, a simple rendering of a face **520** (shown in **FIG. 5B**). Additionally, the face **520** may be animated, such as, but not limited to, the face **520** changing shape to visually alter the face **520** in the form of a wink, a smile, and so forth, as wireless mobile phone **500** moves back and forth, and the LEDs are being activated/deactivated.

In one embodiment, the assembled wireless mobile phone **500** (shown in **FIG. 5A**) may be static, i.e., not moved at all, and the luminescent image, the face **520** (shown in **FIG. 5B**), may be painted scrolling across the LEDs **415** in the matrix arrangement. Additionally, the luminescent image may also change to be animated as it scrolls across the LEDs **415**. For example, the luminescent image may change shape to smile or wink, and so forth.

As described earlier, the number of LEDs may vary. A greater number of LEDs can provide higher resolution images and greater visibility. For example, in addition to the LEDs beneath the keys, LEDs may be also be embedded on or affixed to the covering to provide a larger matrix upon which the luminescent images may be generated and displayed. In one embodiment, the wireless mobile phone includes two parallel rows of LEDs. Each LED in one row has a corresponding LED in the second row, forming a pair of corresponding LEDs. Each corresponding pair of LEDs is turned on and off simultaneously, thereby expanding the amount of light that is produced. In

general, the activation and deactivation may be further controlled in a manner that is formation dependent, i.e. depending on how the LEDs are grouped and organized in their placements.

Images, such as the examples shown in **FIG. 5B**, may be pre-installed in a non-volatile memory (shown as ref. **910** in **FIG. 9**), or alternatively, may be retrieved from an Internet address, where the address specifications may be in the form of one or more Uniform Resource Identifiers (URI). An image can also be transferred to the mobile phone using instant messaging communications, by a telephone call, or using a graphical manipulation tool on the wireless mobile phone. Text to be displayed can be entered by using any of the text input mechanisms on the mobile phone, such as the keys **425**.

In one embodiment, the body casing of the wireless mobile phone may have LEDs embedded in more than one side. For example, a body casing of a wireless mobile phone may have both LEDs embedded in a substantially columnar manner, along a longitudinal axis (shown in **FIGS. 1-3**) and LEDs disposed below keys (shown in **FIG. 4A**). In this example, when the wireless mobile phone is moved in two directions **210 & 211** (shown in **FIG. 2**), the LEDs embedded in the columnar manner, along the longitudinal axis, are activated and deactivated to spatially paint a first luminescent image similar to the luminescent image **220** (shown in **FIG. 2**). In addition, a second luminescent image is spatially painted by the LEDs disposed below the keys. The second luminescent image having a three-dimensional quality to it, because the second luminescent image moves towards and away from the viewer.

In addition to the motions described, i.e. side-by-side, arc like, and so forth, the present invention may be practiced with other patterns of motions, including in particular, but are not limited to, a circular pattern of motion.

In one embodiment, in addition to employing one group of LEDs to spatially paint images for other viewers, another group of LEDs may be employed to spatially paint the same images, or provide certain visual indicators for the user of the wireless mobile phone. The LEDs visible to the user may aid the user in timing the motion of the wireless mobile phone to spatially paint a clearer luminescent image. As alluded to earlier, the user may be aided by the LEDs, placed for the viewing of the user, spatially painting an identical luminescent image as the one being projected to others. The user moves the wireless mobile phone at a rate to spatially paint a clear luminescent image for himself/herself.

Alternatively, a single timing LED may be employed instead. The timing LED is located in a position such that it is visible by the user while the user is moving the phone as described above. As the wireless mobile phone is in motion, the user tries to maintain a luminescent image of a solid line painted by the timing LED. The optimal speed of movement is the minimum necessary to maintain a view of a solid line. Faster movement causes the image to become compressed. Slower movement causes the image to become unclear or broken. The timing LED maintains an "on" state during the procedure of painting an image. Alternatively, the timing LED may alternate on and off at a rate such that the optimal speed of movement causes a dotted line to be displayed. In yet other embodiments, an audible tone may be employed to guide the user in moving the phone at a speed that yields better visual results. For example, a "beeping"

tone may be provided to serve as a guide to the user. In yet other embodiments, tactile feedback, such as vibration, may be provided to guide the user.

As a result, spatial painting of luminescent images, including animated images, is facilitated utilizing a wireless mobile phone.

FIGURE 6 illustrates an alternate configuration of a wireless mobile phone for facilitation of spatial painting of luminescent images utilizing a wireless mobile phone in an alternate configuration. As shown in **FIG. 6**, a wireless mobile phone **600** with inverted placement of antenna and keypad includes a speaker area **601**, a number of keys **602** directly below the speaker area **601**, a display area **603** disposed below the keys **602**, and a microphone area **604**. An example of a wireless mobile phone with inverted placement of antenna and keypad is disclosed in related U.S. Patent Application titled "A WIRELESS MOBILE PHONE WITH INVERTED PLACEMENT OF ANTENNA AND INPUT KEYPAD", Ser. No. 09/767,526 filed 1/22/2001, the subject matter of which is incorporated herein by reference. Additionally, the body casing has LEDs **610** disposed on one of its side exterior surface, parallel to the longitudinal axis **111** and opposite an antenna **605**, in accordance with the teachings of the present invention. As previously described, the body casing of the wireless mobile phone **600** may have LEDs **610** disposed in a variety of alternative manners, such as, but not limited to, a matrix arrangement disposed beneath keys **615**. Additionally, as previously described, the wireless mobile phone **600** may spatially paint luminescent messages either when in motion or when static, based at least upon the number and arrangement of the LEDs **610**. The wireless mobile phone **600** with inverted placement of antenna

and keypad facilitates augmenting the motion of the wireless mobile phone as will be described in the text accompanying **FIGS. 7A & 7B**.

FIGURES 7A & 7B illustrate means for augmenting motion of a wireless mobile phone utilized to spatially paint a luminescent image, in accordance with one embodiment of the present invention. As shown in **FIG. 7A**, a wireless mobile phone **700** is in an inverted configuration with LEDs **710** disposed beneath the keys **702**. In **FIG. 7A**, a cantilever attachment **705** is attached to an antenna **706** extending in a vertical direction, parallel to the longitudinal axis **111**, below the bottom surface of the wireless mobile phone **700**. This addition of the lever arm to the wireless mobile phone **700** facilitates an increase in the rate of the side-to-side motion when wireless mobile phone is held by the cantilever attachment **705**, i.e., an increase in the angular acceleration of the inverted configuration wireless mobile phone **700**. In the embodiment shown in **FIG. 7A**, the cantilever attachment **705** is used to move the inverted wireless mobile phone **700** in a side-to-side motion **715**. This augmenting of velocity of the side-to-side motion **715** improves the resolution of the luminescent images. In various embodiments, the cantilever attachment **705** is made of an elastomeric material, such as, but not limited to, rubber, to enhance the forced vibration resulting from the added cantilever attachment of the inverted wireless mobile phone.

Shown in **FIG. 7A**, the cantilever attachment **705** is a separate part attached to the antenna **706**. However, the cantilever attachment **705** may be any type of extension for increasing the rate of motion of the wireless mobile phone **700** such as, but not limited to, a relatively extended one-piece antenna attached to the body casing. Additionally, this type of augmenting of the motion of a wireless mobile phone may be

applied to any type of wireless mobile phone utilized to facilitate generation and display of luminescent images. When the present invention is practiced on a wireless mobile phone having an antenna located on the top of the phone, the graphic or text image displayed can be inverted in order to be viewed appropriately when the user holds the phone in an inverted position, with the antenna pointed downward.

Referring now to **FIG. 7B**, one embodiment of a wireless mobile phone **700** with inverted placement of antenna and keypad is illustrated, having the LEDs **710** disposed parallel to the longitudinal axis **111** on the side opposite a bending antenna **720**. In **FIG. 7B**, the bending antenna **720** is shown bent 90 degrees to the vertical at a bend point **721**. The bending antenna **720** is held by a user at a handle **722** with the handle **722** locked in the bent position. The locking of the bent position may be achieved by any known mechanical locking method. The user proceeds to rotate the wireless mobile phone **700** about the handle **722** facilitating a higher rate of rotation of the wireless mobile phone **700**. This higher rate of rotation improves the resolution of the luminescent images. Here again, the placement of the LEDs **710** may be in any location in/on the wireless mobile phone **700**, and the bending antenna **722** may be configured to bend in alternate directions in order face the LEDs **710** towards the most effective direction. While **FIG. 7B** illustrates how a wireless mobile phone with inverted placement of antenna and keypad may be augmented to allow a user to control spatial movement, traditionally oriented wireless mobile phone may also be augmented in a similar manner.

As a result, motion of a wireless mobile phone utilized to facilitate spatial painting of luminescent images may be augmented, in accordance with one embodiment of the present invention.

FIGURES 8A-8C illustrate spatial painting of luminescent images utilizing a wireless mobile phone having a body casing comprising two portions, one of which is interchangeable, in accordance with the teachings of the present invention. **FIGS. 8A & 8B** show a wireless mobile phone having a body casing comprising an exposed wireless mobile phone **800** and an interchangeable covering **820**. The exposed wireless mobile phone **800** and the interchangeable covering **820** are oriented such that the left side of the exposed wireless mobile phone **800** (shown in **FIG. 8A**) corresponds to the right side of the interchangeable covering **820** (shown in **FIG. 8B**), i.e., **FIG. 8B** is a view of the inside of the interchangeable covering **820**.

In accordance with one embodiment of the present invention, interchangeable covering **820** includes an embedded electronic component **823** having data/programming for generating and displaying luminescent images corresponding to a theme of the interchangeable covering **820**.

In alternate embodiments, interchangeable cover **820** may be an accessory cover that does not form a part of wireless mobile phone **800**. Such a cover is adorned by wireless mobile phone **800** as an accessory, like jewelry and scarf are adorned to complement clothing.

An example of an interchangeable covering is disclosed in related U.S. Patent Application titled "METHOD AND APPARATUS FOR PERSONALIZING MOBILE ELECTRONIC DEVICES INCLUDING INTERCHANGEABLE COVERINGS WITH

EMBEDDED PERSONALITY", Ser. No. 10/087,098, filed March 1, 2002, the subject matter of which is incorporated herein by reference.

Another example of an interchangeable covering is disclosed in related U.S. Patent Application titled "Personalization of Mobile Electronic Devices using Smart Accessory Covers", Ser. No. <to be inserted>, filed May 2, 2003, the subject matter of which is also incorporated herein by reference.

The data and/or programming logic to control the activation and deactivation of LEDs to facilitate spatial painting of luminescent messages may be stored in an electronic component of the wireless mobile phone such as a non-volatile memory (shown as ref. **910** in **FIG. 9**), or alternatively, in the electronic component **823** of the interchangeable covering **820**. The electronic component may be a microprocessor, a memory, a combination of both, or other electronic components of the like.

In the embodiment shown in **FIGS. 8A-8C**, electronic component **823** of the interchangeable covering **820** may include a theme, such as, but not limited to, dairy products. The data and/or programming logic stored in the electronic component **823** of the interchangeable covering **820** may include images related to dairy products. Once a user attaches the interchangeable covering **820** to the wireless mobile phone having a coupler **810** to form an interface with the electronic component **823**, a luminescent image that is automatically generated and displayed may be a dairy related image, shown for example in **FIG. 8C**. Additionally, the luminescent image generated and displayed may be a luminescent image of a cow, and so forth.

In **FIGS. 8A-8C**, as previously described, LEDs may be disposed in a variety of ways contemplated within the spirit and scope of the invention on the exposed wireless

mobile phone **800** and/or interchangeable covering **820**. In various embodiments, interchangeable covering **820** may be an interchangeable faceplate, while in other embodiments, covering **820** may be an interchangeable "skin".

As a result, spatial painting of luminescent images utilizing a wireless mobile phone is facilitated incorporating interchangeable coverings is described, in accordance with the teachings of the present invention.

FIGURE 9 illustrates an internal component view of a wireless client device such as a wireless mobile phone (shown as refs. **100, 400, 500, 600, 700, and 800**), in accordance with one embodiment of the present invention. As illustrated, wireless device **900** includes elements found in conventional mobile client devices such as micro-controller/processor **903**, digital signal processor (DSP) **902**, communication interface **911**, transmitter/receiver (TX/RX) **913** (also known as transceiver), and general-purpose input/output (GPIO) **915**. Except for the teachings of the present invention, these elements perform their conventional functions known in the art, including facilitating a user in communicating with another user of another communication device. The communication may be voice or data.

In particular, TX/RX **913** may support one or more of any of the known signaling protocols, including, but not limited to, code division multiple access (CDMA), time division multiple access (TDMA), global system for mobile communications (GSM), cellular digital packet data (CDPD), and so forth. Similarly, communication interface **911** may support one or more wireless communication protocols including, but not limited to, infrared, Bluetooth, IEEE 802.11b, and so forth. It should be noted that one or more of these elements may be omitted without departing from the spirit and scope of

the invention. For example, since the luminescent images are generated and displayed utilizing wireless mobile phones, speaker and microphone of wireless mobile phone (shown as refs. **100, 400, 500, 600, 700, and 800**) may be omitted because the luminescent images may be communicative in nature, but however, this need not be the case. As their constitutions are known, these elements will not be further described.

Wireless mobile phone **900** includes LEDs **904**, and complementary logic **907** for LEDs **904** hosted by the non-volatile memory **910**. Complementary logic **907** includes logic executed by the micro-controller/processor **903** to selectively activate/deactivate the LEDs **904** (shown as refs. **110, 415, 610, and 710**). In one embodiment, the complementary logic causes the micro-controller/processor **903** to selectively activate the LEDs **904** to generate and display luminescent images.

Additionally shown in **FIG. 9** is an accelerometer **950** to transmit data signals to the micro-controller/processor **903** regarding changes in acceleration corresponding to changes in direction of motion of the wireless mobile phone **900**. In order to accommodate the small size of the components in a wireless mobile phone **900**, the accelerometer may be any type of micro-miniature accelerometers known, such as, but not limited to, a piezoelectric micro-miniature accelerometer. The accelerometer **950** sends signals to the micro-controller/processor **903** to coordinate the selective activation of the LEDs **904**. In alternate embodiments, other mechanisms for sensing one or more movement attributes indicative of the spatial movement of the phone, such as the movement speed or rate, may also be employed instead.

FIGURE 10 illustrates an internal component view of an interchangeable covering having an electronic component, such as the electronic component **823** of **FIG.**

8, in accordance with one embodiment of the present invention. As illustrated, interchangeable covering **1000** has an embedded electronic component **1020**. The electronic component may be a microprocessor, a memory, or a combination of both. Additionally, the interchangeable covering **1000** optionally includes elements such as GPIO **1015** and an accelerometer **1025**.

The interchangeable covering **1000** includes LEDs **1004**, and complementary logic **1007** for the LEDs **1004** hosted by the electronic component **1020**. The complementary logic **1007** includes logic executed by the electronic component **1020** to selectively activate the LEDs **1004**, where these LEDs may be disposed in the interchangeable covering or disposed in the body casing (shown as refs. **110, 415, 610,** and **710**). The complementary logic **1007** in the interchangeable covering **1000** may be executed to selectively activate LEDs in a body casing to spatially paint a pre-stored luminescent image, such as the luminescent image shown in **FIG. 8C**. Alternatively, the complementary logic **1007** in the interchangeable covering **1000** may be executed to selectively activate LEDs **1004** in the interchangeable covering **1000** itself.

FIGURE 11 illustrates turning on and off LEDs to spatially paint a luminescent image, in accordance with one embodiment of the present invention. Shown in **FIG. 11**, is an example of a specification of an image **1101** to be spatially painted, such as, but not limited to, a text string of a single character, "S". Also shown in **FIG. 11**, is a bitmap **1105** corresponding to the specification of the image **1101**. The bitmap **1105** is shown comprising of asterisks **1106** representing LEDs lit at particular points of a spatial movement cycle to spatially paint the luminescent specification of the image **1101**. Blank areas **1107** of the bitmap **1105** represent LEDs being turned off at the various

points of the spatial movement cycle. A movement cycle is movement from one extreme end spatial position to another, e.g. from the left spatial end to the right spatial end, or from the right spatial end to the left spatial end.

In one embodiment, LEDs are turned on, turned off, or have the on/off state maintained (i.e. unchanged) based at least upon a matrix of commands **1110**. The matrix of commands **1110** is translated from the specification of the image **1101**, and corresponds to a cycle of activity for the LEDs. As shown in **FIG. 11**, the matrix of commands **1110** includes commands to turn LEDs on ("O") **1115**, commands to turn LEDs off ("X") **1120**, and commands to leave LEDs unchanged ("-") **1125** for the various points of the spatial movement cycle. The commands occupying the same column position in matrix **1100** are executed at the same time. In **FIG. 11**, the commands illustrated are for an exemplary left to right movement (from the viewer's perspective). The corresponding commands for the reverse right to left movement may be derived from the illustrated commands by "transposing" the "first" "on" command and the "last" ""unchanged" command of each sequence of "on" and "unchanged" commands of each row. For example, the illustrated sequence of "O---" of the first row (executed from left to right) for the left to right movement is changed to "---O" for the reverse right to left movement (executed from right to left). The leave unchanged command ("-") **1125** helps prevent LEDs from having unnecessary commands, i.e., when LEDs already have the turn on ("O") **1115** or the turn off ("X") **1120** commands, and the LEDs are to remain "on" or "off" correspondingly. Under these circumstances, the on/off commands need not be repeated for these LEDs.

The embodiment shown in **FIG. 11** illustrates a specification of an image for a text string having a single character. However, as previously described, the specification of the image may comprise a text string having multiple characters or may be part of an image, such as the image shown in **FIG. 5B**. If specification of an image comprises a text string of multiple characters, a command to turn all of the LEDs off after spatially painting each letter may also be implemented.

FIGURE 12 illustrates an operational flow of the complementary logic as it applies to the facilitation of spatially painting luminescent images utilizing a wireless mobile phone, in accordance with one embodiment of the present invention. The process begins at block **1202** where a specification of an image to be spatially painted is received. As described earlier, the luminescent image is to be spatially painted using the LEDs. The specification of the image is translated to a matrix of commands to turn the LEDs on, off, or to leave the LEDs unchanged **1203**.

Once the specification of the image is translated to a matrix of commands, a cycle counter is initialized, and as previously described, an accelerometer may provide an indication of direction of motion to display non-direction dependent image **1204**, i.e., preventing backward images. The matrix of commands is utilized to turn on, to turn off, and to leave unchanged LEDs during a cycle of activity of the LEDs **1205**.

At the end of the cycle of activity of the LEDs, it is determined if a change in direction of motion is detected **1206**. If a change in direction of the motion is detected, the cycle counter is initialized again with an indication of direction to spatially paint the image in a reverse direction in order to prevent a backward image. However, if the direction of motion is not changed, an increment or decrement of the specification of the

image is counted, i.e., the subsequent images or parts of the images to be spatially painted **1207**.

As the specification of the image is spatially painted in increments or decrements, it is determined if the end of the image is reached **1208**. If the end of the image is spatially painted, i.e., the specification of the image has been completely spatially painted, it is determined if a change in direction of the motion is detected. However, if the end of the image has not been spatially painted, the activity of the LEDs is continued.

FIGURES 13a-13c illustrate spatial painting of illumination images utilizing a wireless mobile phone, in accordance with another family of embodiments of the present invention. For ease of understanding, this family of alternate embodiments is illustrated in the context of spatially painting portions of the same exemplary images **220a** and **240a** of **Figs. 2a-2b**. Of course, this family of embodiments is not so limited, and it may be employed to spatially paint any image.

Wireless mobile phone **1100** of this family of alternate embodiments differs from the earlier described embodiments in that in lieu of externally disposed LEDs **110**, phone **1100** is provided with a light source arrangement, such as a laser diode, to facilitate spatial painting of illumination images. For the illustrated and preferred embodiments, the light source arrangement is internally disposed, i.e. within the internal space defined by the body casing of phone **1100**. However, even though not preferred, these embodiments may nevertheless be practiced with some of all of the elements of the light source arrangement being externally disposed, i.e. outside of the internal space defined by the body casing of phone **1100**. Moreover, other embodiments may practice

with both the luminescent as well as the illumination teachings of the present application.

As will be described in more details later referencing **Fig. 14, 15a-15c**, and **16-18**, in various implementations, the light source arrangement may include one or more collimated light sources, such as a laser diode or LED complemented with appropriate focusing lens, and zero or more mirrors, aligned and/or operated in a coordinated manner to provide a sweeping collimated light pulse **1110** to facilitate spatial painting of an illuminated line (e.g. along imaginary axis **1111**) on a surface, such as surface **1214**, in each of the very small fractions of a second, phone **1100** holds a point in space.

Figure 13b illustrates the spatial painting of **Fig. 13a** and **13c** from another view, more specifically, from a view orthogonal to the views of **Fig. 13a** and **13c**. The view from which **Figure 13b** is illustrated, is depicted in **Fig. 13a** as well as **Fig. 13c**.

Thus, with selective activation and deactivation of the light source in predetermined very small intervals of time (preferably of equal sizes), the illuminated line spatial painted by the light source may spatially paint a broken line, such as lines **1112a-1112e**, effectively providing the ability to render a row or column of pixels **1113** (depending on the orientation of phone **1100**). When coupled with the side-to-side movements (directions **210-211** in the case of **Fig. 13a**) or up-and-down movements (directions **210-211** in the case of **Fig. 13c**) as earlier described, the ability to render an array of pixels **1114** (which may also be considered as a bit map) is provided.

In other words, under this family of alternate embodiments, the effect of a row/column of the earlier described LEDs is effectuated through sweeping light pulse **1110** instead.

However, in the case of the earlier embodiments, as described, the luminescent images are painted with the mobile communication device endowed with the earlier described teachings of the present invention, facing the intended audience. In contrast, for this family of alternate embodiments, the illumination images are typically painted with phone **1100** facing an opaque "canvas" **1214**, such as a wall or other opaque planar surfaces, with opaque "canvas" **1214** being in the line of sight of the intended audience instead. However, for this family of alternate embodiments, the illumination images may also be painted with phone **1100** facing one side of a semi-transparent "canvas" **1214**, and the opposite side of semi-transparent "canvas" **1214** being in the line of sight of the intended audience.

As will be described in further details below, in various embodiments, the light source arrangement is advantageously designed to allow light pulse **1110** to be held steady, as opposed to being sweeping (when it is used to paint illumination images), to enable phone **1100** to be also useable as a light pointer.

For the embodiment, to facilitate emission of light pulse **1110** (whether sweeping or held steady), the body casing includes photonic opening **1105**. Opening **1105** is referred to as "photonic" in that, the portion of the body casing of phone **1100** occupied by photonic opening **1105** is constituted with materials that allows pass through transmissions of photons, and therefore making emission of light pulse **1110** possible.

In various preferred implementations, photonic opening **1105** includes "narrowly" focused diffuser lens (not shown) to facilitate a relative small amount of diffusion of the emitted light pulse **1110**, thereby "widening" the illuminated line of pixels being spatially painted.

In other implementations, the alternate embodiments may be practiced employing other means of narrow diffusion, or without diffusion. Further, the alternate embodiments may be practiced with photonic opening **1105** being a plain physical opening instead.

FIGURE 14 illustrates the light source arrangement of the wireless mobile phone of **Fig. 13a-13c** in further details, in accordance with one embodiment. For the embodiment, the light source arrangement includes a collimated light source, such as a laser diode or LED complemented with focusing lens. The laser diode/LED may be a single color laser diode/LED or a multi-color laser diode/LED.

More specifically, the collimated light source is provided with the mobility to occupy a number of deterministic positions in space at different times, with particular optical alignments to photonic opening **1105**. **Fig. 14** illustrates the light source in two positions in space and time **1402a-1402b**.

For the embodiment, the deterministic spatial positions the light source may occupy are the positions on the portion of the circumference or "orbit" **1405a** defined by angular range **1408a**. In each of these positions, the light source forms a different optical relationship with photonic opening **1105**, emitting with a different angular disposition.

Thus, during operation, as the operating logic of phone **1100** rapidly and successively moves the light source between these deterministic positions, sweeping light pulse **1110** may be formed. Further, as the operating logic of phone **1100** selectively activates/deactivates the light source, a row/column of pixels **1112** (with a desired combination of on and off effects) for an illumination image may be painted.

The movement of the light source between the positions on the portion of the circumference/orbit **1405a** defined by angular range **1408a** may be characterized as the light source rotating relative to axis **1406a** within the constrained angular range **1408a**. As illustrated, axis **1406a** is orthogonal to the plane of view of **Fig. 14**.

In various implementations, the light source is attached to a moveable platform (not shown) that may be moved in the desired manner under the control of the operating logic, providing the light source with the desired mobility. In one implementation, the moveable platform is a re-positioned vibrator, such as a galvanometer, commonly found in most wireless mobile phones. Except for phone **1100**, it is controlled by the operating logic in the described manner, when employed to assist in the rendering of illumination images.

FIGURES 15a-15c illustrate the light source arrangement of the wireless mobile phone of **Fig. 13a-13c** in further details, in accordance with a number of other embodiments. For the embodiments, the light source arrangement includes one or more collimated light sources (such as laser diodes or LED complemented with focusing lens), and one or more mirrors, complementarily aligned and/or operated.

More specifically, for the embodiment of **Fig. 15a**, the light source arrangement includes a collimated light source **1402** and a mirror with mobility to occupy a number of deterministic positions in space with particular optical alignments to light source **1402** and photonic opening **1105**. **Fig. 14a** illustrates the mirror in two positions in space and time **1404a-1404b**.

For the embodiment, the deterministic spatial positions the mirror may occupy are the positions on the portion of the circumference or "orbit" **1405a** defined by angular

range **1408a**. In each of these positions, the mirror forms a different optical relationship with light source **1402**. In particular, in each of these positions, the reflection of light pulse **1410** outputted by light source **1402**, i.e. light pulse **1110**, emits through photonic opening **1105** with a different angular disposition.

Thus, during operation, as the operating logic of phone **1100** rapidly and successively moves the mirror between these deterministic positions, sweeping light pulse **1110** may be formed. Further, as the operating logic of phone **1100** selectively activates/deactivates light source **1402**, a row/column of pixels **1112** (with a desired combination of on and off effects) for an illumination image may be painted.

The movement of the mirror between the positions on the portion of the circumference or "orbit" **1405a** defined by angular range **1408a** may be characterized as the mirror rotating relative to axis **1406a** within the constrained angular range **1408a**. As illustrated, axis **1406a** is parallel to the plane occupied by the mirror, both of which are orthogonal to the plane of view of **Fig. 15a**.

In various implementations, the mirror is attached to a moveable platform (not shown) that may be moved in the desired manner, under the control of the operating logic, providing the mirror with the desired mobility. In one implementation, the moveable platform is a re-positioned vibrator (such as a galvanometer), commonly found in most wireless mobile phones. Except for phone **1100**, it is controlled by the operating logic in the described manner, when employed to assist in the rendering of illumination images.

While various mirrors known in the art or to be designed may be employed, in preferred embodiments, the mirror is a "first surface" mirror.

In alternate embodiments, light source **1402** may not be in direct optical alignment with mirror in positions **1404a-1404b**. Additional mirrors may be employed to focus the light outputted by light source **1402** to mirror in positions **1404a-1404b**.

In particular, in one implementation, as illustrated in **Fig. 18**, light source **1402** comprises a number of single color laser diodes **1402R**, **1402B**, and **1402G**, and a number of color selecting mirrors **1424a-1424c** optically coupled to each other as shown. More specifically, the single color laser diodes comprise red (R) laser diode **1402R**, green laser diode **1402G** and blue laser diode **1402B** outputting laser lights in the red, green and blue spectrum respectively. The red, green and blue spectrum laser lights are correspondingly reflected off color selection mirrors **1424a-1424c** and integrated, to form color laser light **1410**, as illustrated.

Figure 15b illustrates another embodiment of the light source arrangement. For the embodiment, the light source arrangement also comprises collimated light source **1402**, and a mirror optically aligned with light source **1402** and photonic opening **1105** as shown. Similar to the embodiment of **Fig. 15a**, the mirror is also configured to be able to occupy a number of deterministic spatial positions at different points in time. Again, two of these mirror positions in space and time **1404a** and **1404b** are illustrated, and each of these positions forms a different optical relationship with light source **1402** and photonic opening **1105**. As a result, the reflection of the light pulse **1410** outputted by light source **1402**, i.e. light pulse **1110**, again may emit through photonic opening **1105** with different angular dispositions.

Therefore, during operation, as the operating logic of phone **1100** rapidly and successively moves the mirror between these deterministic positions, sweeping light

pulse **1110** may be formed. Further, as the operating logic of phone **1100** selectively activates/deactivates light source **1402**, a row/column of pixels **1112** (with the desired on and off effects) for an illumination image may be painted.

For the embodiment, the movement of the mirror between the positions may be characterized as the mirror rotating relative to axis **1406b** within the angular range **1408b**. As illustrated, axis **1406b** is co-planar to the plane occupied by the mirror, both of which are orthogonal to the plane of view of **Fig. 15b**.

In various implementations, the mirror is attached to a moveable platform (not shown) that may be moved in the desired manner, under the control of the operating logic, providing the mirror with the desired mobility. In one implementation, the moveable platform in a re-positioned vibrator (such as a galvanometer), commonly found in most wireless mobile phones. Except for phone **1100**, it is controlled by the operating logic in the described manner, when employed to assist in the rendering of illumination images.

Figure 15c illustrates another embodiment of the light source arrangement. For the embodiment, the light source arrangement also comprises a collimated light source, and mirror **1404** optically aligned with the light source and photonic opening **1105** as shown. Similar to the embodiments of **Fig. 15a-15b**, mirror **1404** and the light source may assume different optical alignments during operation, to enable sweep light pulse **1110** to be emitted, and a row/column of pixels **1112** to be painted.

However, unlike the embodiments of **Fig. 15a-15b**, mirror **1404** is "fixed". Instead, the light source is configured to be able to occupy a number of deterministic spatial positions at different points in time (as in **Fig. 14**). Two of these light source

positions in space and time **1402a** and **1402b** are illustrated, and each of these positions forms a different optical relationship with mirror **1404**. As a result, the reflections of the light pulses **1410a-1410b** outputted by the light source in positions **1402a-1420b**, i.e. light pulse **1110**, may emit through photonic opening **1105** with different angular dispositions.

Thus, during operation, as the operating logic of phone **1100** rapidly and successively moves the light source between these deterministic positions, sweeping light pulse **1110** may be formed. Further, as the operating logic of phone **1100** activates/deactivates the light source, a row/column of pixels **1112** (with the desired on and off effects) for an illumination image may be painted.

For the embodiment, the movement of the light source between the positions may be characterized as the light source rotating relative to axis **1406c** within the constrained angular range **1408c**. As illustrated, axis **1406c** is orthogonal to the plane of view of **Fig. 15c**.

In various implementations, the light source is attached to a moveable platform (not shown) that may be moved in the desired manner, under the control of the operating logic, providing the light source with the desired mobility. In one implementation, the moveable platform in a re-positioned vibrator (such as a galvanometer), commonly found in most wireless mobile phones. Except for phone **1100**, it is controlled by the operating logic in the described manner, when employed to assist in the rendering of illumination images.

Figure 16 illustrates yet another embodiment of the light source arrangement. For the embodiment, the light source arrangement also comprise collimated light source **1402**, and a mirror optically aligned with light source **1402** and photonic opening **1105** as shown. Similar to the embodiments of **Fig.15a-15c**, the mirror and light source **1402** may assume different optical alignments during operation, to enable sweep light pulse **1110** to be emitted, and a row/column of pixels **1112** to be painted.

While similar to the embodiments of **Fig. 15a-15b**, the mirror is provided with mobility, to enable it to be moved and occupy different spatial positions at different points in time. However, unlike the embodiments of **Fig. 15a-15b**, the mirror does not move in a constrained "circular" manner. Instead, the mirror is configured to be able to move linearly along axis **1406c** for a constrained linear range **1408c**. Again, two of these mirror positions in space and time **1404a** and **1404b** are illustrated, and each of these positions forms a different optical relationship with light source **1402**. As a result, the reflections of the light pulses **1410a-1410b** outputted by light source **1402**, i.e. light pulse **1110**, may emit through photonic opening **1105** with different angular dispositions.

Thus, during operation, as the operating logic of phone **1110** rapidly and successively moves the mirror between these deterministic positions, sweeping light pulse **1110** may be formed. Further, as the operating logic of phone **1110** selectively activates/deactivates light source **1402**, a row/column of pixels **1112** (with the desired on and off effects) for an illumination image may be painted.

In various implementations, the mirror is attached to a moveable platform (not shown) that may be moved in the desired manner, under the control of the operating logic, providing the mirror with the desired mobility. In one implementation, the

moveable platform in a re-positioned vibrator (such as a galvanometer), commonly found in most wireless mobile phones. Except for phone **1100**, it is controlled by the operating logic in the described manner, when employed to assist in the rendering of illumination images.

Figure 17 illustrates yet another embodiment of the light source arrangement. The embodiment is similar to the embodiment of **Figure 15a**, except the light source arrangement, in addition to collimated light source **1402**, includes multiple mirrors (including mirrors **1404a** and **1404b**). More specifically, the multiple mirrors (including mirrors **1404a** and **1404b**) are arranged in a polygon configuration around "orbit" **1405a**. The multiple mirrors (including mirrors **1404a** and **1404b**) are similarly provided with mobility, more specifically, the ability to rotate around axis **1406a**, which as before, is orthogonal to the plane of view of **Fig. 17**. In various implementations, the mirrors (including mirrors **1404a** and **1404b**) are attached to a moveable platform (not shown) that may be move in the desired manner, under the control of the operating logic, providing the mirrors with the desired mobility. In one implementation, the moveable platform in a re-positioned vibrator (such as a galvanometer), commonly found in most wireless mobile phones. Except for phone **1100**, it is controlled by the operating logic in the described manner, when employed to assist in the rendering of illumination images.

Collimated light source **1402** and the mirrors are optically aligned with each other and with photonic opening **1105** as shown. Thus, in lieu of forming different optical relationships with one mirror at different times (as the mirror is moved back and forth with a constrained angle range), collimated light source **1402** successively assumes different optical alignments with the multiple mirrors at different times during operation,

to enable sweep light pulse **1110** to be emitted, and a row/column of pixels **1112** to be painted.

The resulting effect is that the successive illuminated "lines" (rows/columns) of pixels **1112** are substantially parallel to each other as illustrated in **Fig. 17**, as opposed to every other successive illuminated "lines" (rows/columns) of pixels being substantially parallel to each other, as illustrated in **Fig. 13a** and **13c**. For the embodiments of **Fig. 14, 15a-15c** and **16**, the adjacent "lines" (row/columns) of pixels tend to slightly angle away from each other as illustrated in **Fig. 13a** and **13c** (as the mirror or light source changes its direction of movement).

Thus, it can be seen the luminescent or illumination images may be formed with numerous LED and collimated light source arrangements. Certain embodiments may include additional components to the embodiments described. Others may not require all of the above components, or may combine one or more of the described components. In particular, the illumination image forming embodiments may be provided with indicators to assist a user in moving the wireless communication device, as earlier described for the embodiments for forming the luminescent images. Further, the illumination image forming embodiments may be provided with one or more duplicate sets of the light source and/or mirror resources to facilitate concurrent painting of multiple "lines' (rows/columns) of pixels at the same time.

In one embodiment, a portion of the invention, as described above, more specifically, the control logic, may be implemented using one or more micro-controller/processor. In one embodiment, the present invention may be implemented using software routines executed by one or more micro-controller processors.

In one embodiment, the software routines may be written in the C programming language. It should be appreciated that the software routines may be implemented in any of a wide variety of programming languages. In alternate embodiments, a portion of the invention may be implemented in discrete hardware or firmware.

For example, one or more application specific integrated circuit (ASICs) could be programmed with one or more of the above described functions to selectively activate a subset of a number of LEDs or a collimated light source. In another example, one or more functions for spatially painting luminescent/illumination images could be implemented in one or more ASICs on additional circuit boards, and the circuit boards could be inserted into wireless mobile phone or the interchangeable covering described above. In another example, field programmable gate arrays (FPGAs) or static programmable gate arrays (SPGAs) could be used to implement one or more functions of the invention. In yet another example, a combination of hardware and software could be used to implement one or more functions of the invention.

Thus, spatially painting luminescent/illumination images utilizing a wireless mobile phone having LED and/or collimated light source have been described. While the present invention has been described in terms of the above-illustrated embodiments, one skilled in the art will recognize that the present invention is not limited to the embodiments described. The present invention can be practiced with modification and alternation within the spirit and scope of the appended claims. Thus, the description is to be regarded as illustrative instead of restrictive on the present invention.